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OAK WILT DAMAGE

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A Survey in Central Wisconsin

by
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and
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LAKE STATES FOREST EXPERIMENT STATION
M. B. Dickerman, Director

U.S. DEPARTMENT OF AGRICULTURE · FOREST SERVICE

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Lake States Forest Experiment Station [1]

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INTRODUCTION

Reports concerning oak mortality in Minnesota and Wisconsin date back more than half a century. Whether the mortality mentioned in the earlier reports was caused by oak wilt or whether the disease is a relatively recent foreign introduction is unknown, as oak wilt was not recognized as a specific disease caused by a fungus [2] until the early 1940's.[3] More recently oak wilt research has been greatly accelerated by the discovery of the disease in southern and eastern states where the oak type is of great economic importance.

Although the seriousness of the disease is generally recognized, no efforts have been made in the past to evaluate quantitatively the extent of damage over large areas. All available evidence indicates that oak wilt has been present longest and is most prevalent in Minnesota, Wisconsin, and Iowa. The disease thus has had more opportunity to cause damage in this area. For this reason Wisconsin was selected for an oak wilt damage survey.

The purposes of the survey were (1) to make an appraisal of damage, (2) to provide an evaluation of the status of the oak type in this area--that is, whether the oak type with the present prevalence of wilt is still productive--and (3) to search for a possible pattern of future oak wilt development in regions that apparently have been invaded by the disease more recently.

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[1] Maintained by the U. S. Department of Agriculture, Forest Service, in cooperation with the University of Minnesota, St. Paul 1, Minnesota.

[2] The fungus was originally named *Chalara quercina* Henry and later changed to *Endoconidiophora fagacearum* Bretz.

[3] Henry, Berch W., C. S. Moses, C. Audrey Richards, and A. J. Riker. Oak wilt: its significance, symptoms, and cause. Phytopath. 34: 636-647, 1944.

Estimates of the percent of area affected in the oak type and of the volume of oak killed annually are necessary to evaluate the impact of the disease on oak stands. The intensive random sampling required to obtain reliable figures and the limited resources available for the survey precluded coverage of the entire area in Wisconsin that is subject to oak wilt damage. Accordingly, the survey was limited to a group of counties characterized by a large acreage of oak type and the presence of oak wilt. The survey was initiated in the summer of 1953 and completed in 1954.[4]

SURVEY METHODS

To obtain as much oak wilt damage data as possible, counties were selected for which up-to-date, reliable forest inventory estimates were available. Since total oak-type area and oak volume by stand condition classes were known, the field crew could limit time-consuming tallies to the infected areas encountered in the sample. They therefore covered more area more intensively than would have been possible if a complete tally of all oak-type area sampled had been necessary. Two survey methods were used. The first, an aerial survey to determine the area of oak type infected, proved unsatisfactory as described below. Consequently, a ground sample plot survey was made to determine both the area of oak type and volume [5] of oak infected (see map, page 3).

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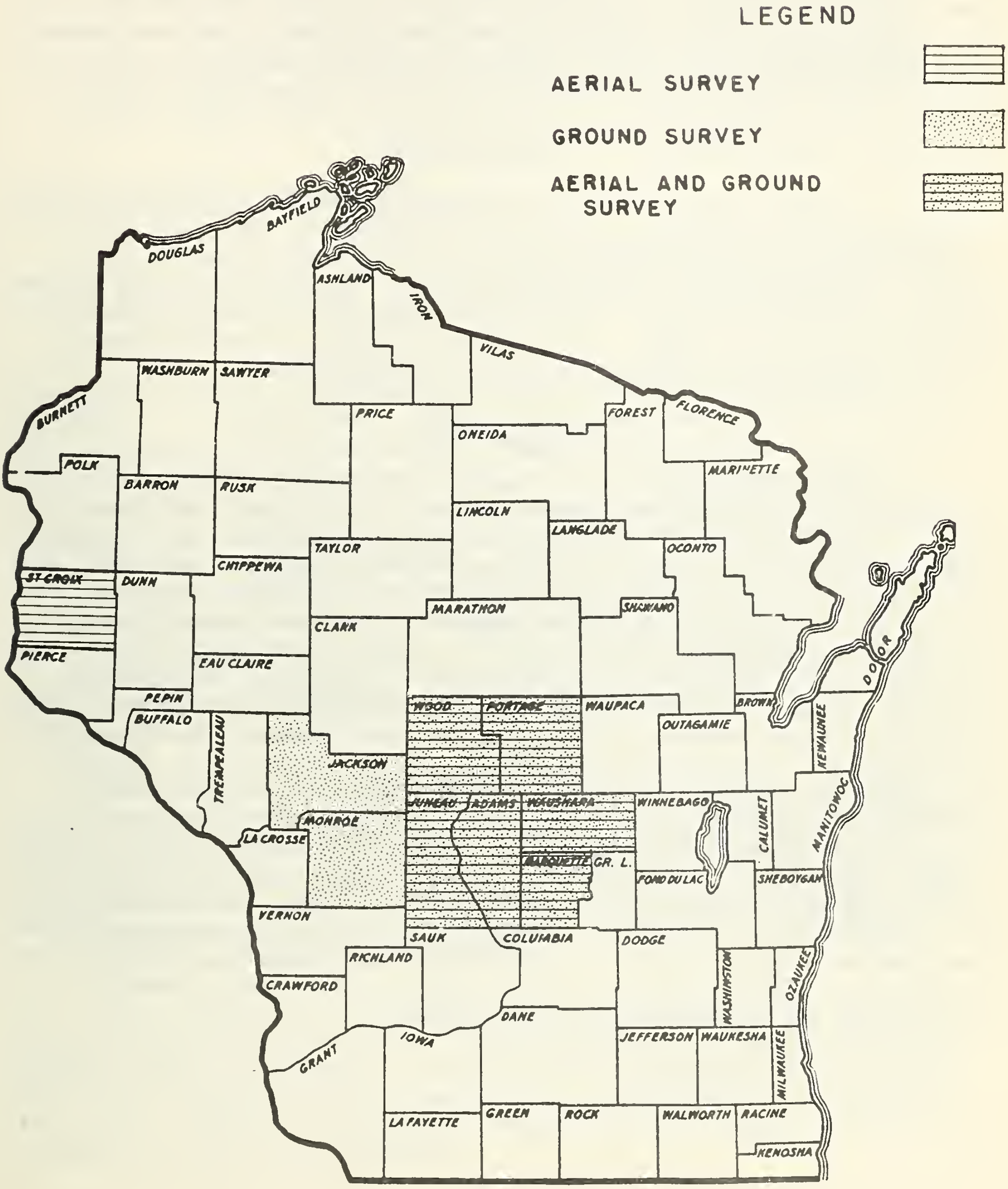
[4] In 1953 the survey was conducted by student assistants Bruce Payne and Elliot Amidon under the direction of Marvin E. Fowler. In 1954 the survey was conducted by student assistants Elliot Amidon and Edward Rousseau under the direction of the authors. The authors wish to express their appreciation for advice and assistance given by the Department of Plant Pathology, University of Wisconsin, and for forest inventory data and aerial photographs made available by the Wisconsin Conservation Department.

[5] Oak trees dying during the current year were recorded in a separate tally to provide data for determining current annual volume loss.

COUNTIES SURVEYED FOR OAK WILT DAMAGE IN WISCONSIN



Aerial Survey

The aerial survey, made in early July, 1953, covered seven counties: Marquette, Waushara, Adams, Portage, Juneau, Wood, and St. Croix. Flight lines were established at 5-mile intervals across these counties. On each flight line a strip 1 mile wide was covered, providing a 20-percent sample. Two observers were used, each man tallying the estimated acreage of all infected areas on a ½-mile-wide strip. These data were then multiplied by five to give the total acreage infected. The infected acreage divided by the total acreage of oak and scrub oak type (from forest inventory data) gave the percent of area infected.

The aerial survey was discontinued because of a number of evident defects which made the ocular estimates of area infected of questionable accuracy. The primary difficulty lay in the large number of small oak wilt infection centers. The estimators had to make very rapid estimates of these many small areas and may even have omitted some of them. For the same reasons, a count of stems or any estimation of volume losses was impractical.

Ground Survey

Because the aerial survey was not considered satisfactory, a ground plot sampling method was adopted. This survey made use of all 1/5-acre sample plots previously established by the Wisconsin Forest Survey in the oak and scrub oak types. Thus the oak wilt estimates are very logically associated with the forest inventory estimates and are based on a good sample of the population, particularly in merchantable size classes. A total of 744 sample plots were visited by the field crews during the summers of 1953 and 1954. These plots were distributed throughout Juneau, Wood, Marquette, Waushara, Adams, Jackson, Monroe, and Portage Counties and results are applicable only to these counties. In the analysis of the oak wilt data due consideration was given to the fact that the Forest Survey took relatively more plots in the merchantable size classes than in the reproduction and sapling areas. The Forest Survey county figures for total area and volume of each condition class in the oak and scrub oak types were used as a basis for computing the percentage of infection. The amount of infection was first computed on a county basis. These figures were then weighted by the relative volume and area in each county to arrive at average figures for the eight-county area surveyed.

SURVEY RESULTS

Aerial Survey

The aerial survey indicated that about 2 percent of the oak and scrub oak types were infected (table 1). This survey was not considered adequate because no volume data were obtained and area computations were made by comparing an ocular estimate to Forest Survey data. Considering the low percent of area infected, errors in ocular estimation could cause appreciable error in the results.

Ground Survey

Area affected and annual mortality

On the basis of the plot survey, approximately 0.3 of a percent of the total volume is killed annually and about 2 percent of the total oak area is infected at the present time (table 2).

Certain counties had a much higher incidence of oak wilt than others. This was particularly true of a four-county block consisting of Juneau, Adams, Waushara, and Marquette Counties. In this area 0.6 of a percent of the total volume is killed annually, and over 4 percent of the total oak area is infected with the disease (table 2). The differences between individual counties may be due in part to sampling errors which are generally large for small acreages of a surveyed area. The fact that in three counties--Jackson, Monroe, and Portage--no wilt was found on the sample plots although oak wilt was present in some adjoining stands verifies this conclusion. On the other hand, the fact that a high percent of infection was obtained in each of four adjoining counties, plus general observation, indicate that oak wilt is actually more prevalent in these counties.

According to the data shown in table 3, the scrub oak type has a higher incidence of infection (3.3 percent) than the oak type (1.8 percent). The distribution of the scrub oak area among the counties, however, does not account for the higher infection in the four-county group. Jackson and Monroe, both outside the group, had no oak wilt on the sample plots although 42 percent of the total scrub oak area is in these two counties.

Six counties were covered by both aerial and ground surveys. The results differ appreciably in that the ground survey data showed twice as much area infected. Although this difference does indicate that ocular estimates made from the air are subject to considerable error, the results of both surveys agree that the percent of area infected is very small (table 4).

Table 1.--Area affected by oak wilt, aerial survey 1953

County surveyed	Area of oak and scrub oak	Area affected in "x" years 1/	Amount of infection in "x" years 1/
	Acres	Acres	Percent
Adams	105,933	1,205	1.1
Juneau	92,646	3,972	4.3
Marquette	50,912	710	1.4
Portage	47,768	167	.3
St. Croix	38,373	1,487	3.9
Waushara	62,441	427	.7
Wood	37,665	776	2.1
Total or weighted average	435,738	8,744	2.0

1/ A survey of average age of infection centers indicates this to be approximately 7 to 10 years.

Table 2.--Area and volume of oak affected by oak wilt in central Wisconsin, ground survey

County surveyed	Area of oak		Volume of oak	
	Total[1]	Infection in "x" years [2]	Total[1]	Annual infection
	Acres	Percent	Cords	Percent
Waushara	61,476	6.23	408,769	0.56
Marquette	50,672	4.88	379,554	.01
Adams	105,298	4.24	670,390	.97
Juneau	92,646	3.13	598,279	.63
Total, high-infection counties	310,092	[3] 4.42	2,056,992	[3] 0.61
Wood	33,197	1.98	285,157	.12
Jackson	128,318	.00	808,434	.00
Monroe	150,545	.00	1,045,704	.00
Portage	46,612	.00	456,299	.00
Total, low-infection counties	358,672	[3] 0.18	2,595,594	[3] 0.01
Total, all counties	668,764	[3] 2.14	4,652,586	[3] 0.28

[1] Includes oak and scrub oak types. Data obtained from the Wisconsin Forest Survey. Due to lack of sample plots in a few condition classes represented by very small areas in individual counties, values may be slightly lower than Forest Survey totals for all condition classes.

[2] A survey of average age of infection centers indicates this to be approximately 7 to 10 years.

[3] Weighted average.

Table 3.--A comparison of oak wilt prevalence in oak and scrub oak types, ground survey

County surveyed	Oak type		Scrub oak type	
	Area[1/]	Average infection	Area[1/]	Average infection
	Acres	Percent	Acres	Percent
Adams	56,384	3.02	48,914	5.65
Jackson	94,766	.00	33,552	.00
Juneau	76,023	1.93	16,623	8.67
Marquette	47,141	4.82	3,531	5.60
Monroe	128,010	.00	22,535	.00
Portage	46,214	.00	398	.00
Waushara	59,187	6.47	2,289	.00
Wood	29,436	2.24	3,761	.00
Total or weighted average	537,161	1.85	131,603	3.35

[1/] Data obtained from the Wisconsin Forest Survey. Due to lack of sample plots in a few condition classes represented by very small areas in individual counties, values may be slightly lower than Forest Survey totals based on all condition classes.

Table 4.--A comparison of aerial and ground surveys for oak wilt in 1953-54

County surveyed	Area of oak and scrub oak[1]	Ground survey	Aerial survey
		Area affected in "x" years [2]	Area affected in "x" years [2]
	Acres	Percent	Percent
Adams	105,298	4.24	1.10
Juneau	92,646	3.13	4.30
Marquette	50,672	4.88	1.40
Portage	46,612	.00	.30
Waushara	61,476	6.23	.70
Wood	33,197	1.98	2.10
Total or weighted average	389,901	3.67	1.83

1/ Data obtained from the Wisconsin Forest Survey. Due to lack of sample plots in a few condition classes represented by very small areas in individual counties, values may be slightly lower than Forest Survey totals based on all condition classes.

2/ A survey of average age of infection centers indicates this to be approximately 7 to 10 years.

Average age of detected infection centers

At least some older infection centers have probably disappeared without leaving any evidence of their presence, that is, by elimination of all susceptible oak in the immediate vicinity. Hence, the total amount of mortality in the area cannot be determined.

Some attempt can be made, however, to estimate the average age of the existing infection centers. Eighteen farmers with typical oak wilt areas in their woodlots were questioned as to when they had first noticed oak dying. The average of all replies indicated that the infection center was 10 years old. Another estimate of the average age can be made if we assume (1) that current annual mortality as determined in the survey is typical of that in past years, and (2) that the average volume of oak on invaded areas was the same as the average volume now on uninfected areas. On these assumptions, the average age can be calculated by dividing the percent of oak area affected by the percent of total volume killed annually. This method estimates the average age at about 7 years, that is, 2.1 divided by 0.28. 6/ On the basis of this evidence the average age of all detected infection centers may be 7 to 10 years.

Growth impact

The impact of oak wilt on annual growth indicates that it is a serious disease. For the eight counties covered in the ground survey, the loss due to annual mortality in merchantable trees is 12,953 cords. 7/ The net annual growth for this area equals 116,315 cords. Therefore, elimination of annual mortality in merchantable trees caused by oak wilt would increase net growth by 11 percent. Thus the current level of infection in the area surveyed causes a serious reduction in productivity.

6/ If 0.28 percent of the volume in a given area is killed annually, then roughly 0.28 percent of the area is infected annually. Accordingly, the 2.1 percent of the area affected over the entire period may be divided by the 0.28 percent affected annually to give the average age of infection centers.

7/ In the Lake States, oaks killed by oak wilt remain reasonably sound for several years and can be salvaged for such uses as posts, fuelwood, and possibly pulpwood. Salvage of sawlogs would have to be made during a relatively short period following mortality to avoid excessive checking.

In addition to the annual mortality in merchantable trees, there are losses which cannot be calculated with accuracy. Annual mortality in seedling and sapling stands, and of small trees in merchantable stands, constitutes an appreciable loss of accumulated growth. Some of the area invaded by oak wilt doubtless will be reoccupied by other species, and in some cases oak may eventually reestablish itself from seed. Nevertheless, an appreciable area is removed from production for an indeterminate period. If the current rate of spread and mortality continues for the next 100 years, from 21 to 30 percent of the oak type will have been invaded.

CONCLUSIONS

The results of this survey indicate that a relatively small percent of the oak type has been invaded by oak wilt to date, even though the disease doubtless has been in the area surveyed for at least 2 decades. Nevertheless, the almost total elimination of oaks from the infected acreage results in a very serious impact on productivity of the oak type for the area surveyed.

The data obtained in this survey should be considered as applying only to large areas, that is, county size or larger. Oak wilt is not uniformly distributed; observation indicates very clearly that in certain localized areas oak wilt has invaded a percent of the oak type area many times as great as the figures presented for this survey and has virtually eliminated some individual stands. Unquestionably, in such areas oak wilt mortality greatly exceeds growth and thus apparently will eliminate oak as a commercially important species in a relatively short time under current conditions.

The survey does not provide any evidence as to the future progress of the disease. Whether the rate of annual spread is about the same from year to year or whether the disease is spreading at an increasing rate is unknown. Neither does the survey explain the present patchy existence of infection centers, that is, is an epidemic still in an early stage of development, or are there factors in the epidemiology of this disease that discourage infection in some areas? Additional research should be instituted to obtain answers to these important questions.

It is difficult to ascertain whether the course of development of the disease in southern and eastern states, where the disease has become established more recently, will simulate that in the area surveyed. If it does, and no control is exercised, undoubtedly the disease will eventually have a serious impact on productivity of the oak type.